BOTANICAL GAZETTE

OCTOBER, 1894.

Filices Mexicanæ. V.[1]

An enumeration of the ferns collected in Mexico by C. G. Pringle of Charlotte, Vermont, during the seasons 1891–1892 and 1893.

GEORGE E. DAVENPORT.

ACROSTICHUM.[2]

A. conforme Swz. 5,195.
On cliffs, Sierra de las Cruces, Oct. 2, 1892.

A. latifolium Swz. 5,530.
Wet cañons, Colima Mts., 7,000ft alt., March 23, 1893.
Specimens agree very well with Chas. Wright's 996, 969, and 3,958 from Cuba in 1859–1865.

A. recognitum Kze.
Sierra de las Cruces, Aug. 25, 1892.

A. venustum Fée, Mem. 8: 68. 5,196.
Moist banks, Sierra de las Cruces, July 10, 1892.

ADIANTUM.

A. trapæsiforme L. 3,960.
Coffee plantation, hacienda of Tamasopo, Dec. 1, 1891.
A grand species with magnificent decompound fronds, the segments from one to one and a half or more inches long, and, in Mr. Pringle's specimens, "decurved obliquely" as in Hooker and Baker's var. *β.* (*A. pentadactylon* L. & F.).

ANEIMIA.

A. hirsuta Swz. 3,850, including var. *tenella* H. & B. (*A. tenella* Swz.) A more delicately cut form, the pinnæ deeply pinnatifid.

[1] For numbers I to IV see *Garden and Forest* 4: 448, 483, 519, 555.
[2] The alphabetical order has been adopted for these notes merely for the convenience of an ultimate re-arrangement.

Cool grassy bluffs of barranca near Guadalajara, Sept. 15, 1891.

ASPIDIUM.

A. aculeatum Swz. 5,532.

A slender nearly smooth form from the cañons of the Colima Mts. May 20, 1893.

A. (Polystichum) *melanostictum* Kze. 3,825.

Shaded slopes of barranca of Las Canoas, Aug. 22, 1891. The large cinnamon colored involucres with black centers and ciliated margins appear to fix Mr. Pringle's plant here with reasonable certainty.

A. (Nephrodium) *setosum* Kl. (*N. tetragonum* Hook.) 3,957, α and β, the two forms so different as to appear like entirely different species, yet not clearly separable by any good characters.

Form α, which is simply pinnate with deeply pinnatifid pinnæ six or more inches long and one inch broad, almost exactly matches Fendler's 194 from Venezuela, 1854–55; form β is nearly tripinnate in the lower half of the frond and broadly deltoid with unequal-sided pinnæ like *A. spinulosum*, var. *dilatatum*, but the upper part gradually and exactly reproduces form α, all other characters being the same in both forms. I am not sure of this determination, but I have found it impossible to place it elsewhere, although I have had it under frequent examination during the past three years.

Banks of a cascade, hacienda of Tamasopo, Dec. 2, 1891.

ASPLENIUM.

A. cicutarium Swz., var. **paleaceum,** n. var. 5,531.

Rachises chaffy, otherwise as in type.

Moist banks, cañons of Colima Mts., May 23, 1893.

A. hastatum Klt. 3,920.

In rich forests, Las Canoas, Oct. 17, 1891.

A. pumilum Swz., var. **laciniatum,** n. var. 5,534.

The divisions deeply cut into linear strap-shaped lobes.

Mossy ledges, barranca of Tepii, Oct. 11, 1893. There is a similar form in the Cambridge Herbarium from Kew (566 from Jamaica) with which this agrees perfectly.

A. rhizophyllum Kze., var. **proliferum,** n. var. 5,533.

Moist banks, cañons of Colima Mts., May 23, 1893.

The exceedingly narrow divisions, and the dareoid appearance of the sori on the upper part of Mr. Pringle's plant led me to look for it in the Darea section of this genus, but Prof. Eaton considers it a mere form of *A. rhizophyllum*, and a more careful examination convinces me that he is right. There are specimens of this species and 5,531 in the Cambridge Herbarium with proliferous fronds, a seemingly not uncommon character in this genus.

A. rubinum, n. sp. 5,191.

Rootstocks tufted, clothed at the crown, and the young croziers covered with blackish-brown fibrillose scales and chaff; fronds clustered, 6 to 15 inches tall, $\frac{3}{8}$ to $\frac{3}{4}$ of an inch broad, pinnate; stipites 2 to 6 inches long, moderately stout, and, as well as the rachises bright ruby colored, smooth and glossy; pinnæ 20 to 30 or more pairs, sessile, or in the larger specimens sub-sessile, variously shaped, mostly unequal-sided, wedge-shaped at base, or sub-dimidiate, the lower side cut away one-half to two-thirds in a curved line with the upper base line parallel with the rachis, lowermost pairs distant, rhomboidal or sub-reniform, margins entire or slightly crenate; surfaces bright green, texture coriaceous, veins obscure, sori large, 1 to 5 pair to a pinna, brown when mature.

Cold cliffs, Sierra de las Cruces, Sept. 11, 1892.

No description can make the distinctive character of this fine ruby-stalked Asplenium perfectly clear, but once seen it is not likely to be mistaken for any other known species.

In general appearance and habit it resembles a robust form of *A. Trichomanes*, but the stout red stalks, which extend nearly to the apex of the frond before greening, and the enormous sori render its identification comparatively easy. The back of a mature pinna is a solid mass of brown sporangia, nearly obscuring the persistent indusia and presenting the appearance of an Acrostichum.

A. Shepherdii Spreng. 3,958, α and β.

Tamasopo cañon, June, 1891.

BOTRYCHIUM.

B. matricariæfolium R. Br. 5,193.

Wet cañons, volcano of Toluca, Sept., 1892.

B. ternatum Swz. 5,192.

Alpine meadows, Sierra de las Cruces, 10,000^{ft} alt., Sept., 1892.

CHEILANTHES.

C. speciosissima A. Br. 4,202 *α* and *β*. (*Plecosorus Mexicana* Fée.)

α, with somewhat rigid fronds densely clothed with rich brown scales; *β* with fronds lax and only sparingly scaly from growing in shady grottos.

Cliffs, Sierra de las Cruces, 11,000^{ft} alt., Sept. 11, 1892.

DICKSONIA.

D. rubiginosa Klf. 3,824.

Rich moist slopes in shade, barranca of Las Canoas, Aug. 18, 1891.

Five to 8^{ft} high, fronds deltoid, 3 to 5^{ft}, stipes 2 to 3^{ft}.

GYMNOGRAMME.

G. Calomelanos Klf., var. *Peruviana* Baker. 4,377. (*G. Peruviana* Desv.)

Calcareous banks and cliffs, barranca near Colima, state of Jalisco, June 4, 1893.

G. Ehrenbergiana Klt., var. **muralis** Pringle (*in litt.*). 4,420.

A cliff-growing dwarf form with chaffy rachises, but without scales. On faces of cliffs near Tequila, July 6, 1893.

G. trifoliata Desv. 4,000.

Barranca of Las Canoas, state of San Luis Potosi, Aug. 15, 1891, growing among willow and cypress bushes.

Specimens bifoliate, and without powder. Judging from the series of specimens at Cambridge, the species is oftener bifoliate than otherwise, and the powder is not always present.

NOTHOLÆNA. This is Robert Brown's original orthography as used by him when he established the genus in 1814, and I do not wish to be quoted as favoring any other. The later orthography of Kaulfuss (1824) in my notes in Garden and Forest, *l. c.*, was not used with my approval, and I do not concede the right of an editor to interfere with an author's manuscript unless it be to correct errors of spelling or grammar. It is not a question of scholarship that we have to consider here, but one of priority and right, and no advocate of the "revised nomenclature" can consistently set aside Brown's original orthography for that of Kaulfuss without doing violence to the very code which he professes to serve.

N. Grayi Davenport. 5,373.

Ledges, barranca of Tequila, Oct. 4, 1893.

Mr. Pringle wrote that "if, as I think, I send you *Noth. Grayi*, it must be from an extreme southerly station, much farther south than before recorded. It was 50 miles west from Guadalajara, where *N. Schaffneri* rather than this species is common."

OPHIOGLOSSUM.

O. crotalophoroides Walt. 4,244.

Moist meadows, Nevado of Toluca, 11,000ft alt., Sept. 6, 1892.

O. reticulatum L. 3,816 and 3,995.

3,816 in moist, grassy places under shrubs, Las Canoas, state of San Luis Potosi, Aug. 15, 1891. 3,995 in wet soil near Guadalajara, state of Jalisco, Oct. 5, 1891. Some of the latter specimens seem doubtfully distinct from *O. vulgatum*; but the two species appear to run very closely together, if not into one another, and I doubt very much if they are specifically distinct.

OSMUNDA.

O. regalis L. No number, and should have been in my previous notes.

By streams near Guadalajara, Dec. 13, 1888.

POLYPODIUM.

P. angustifolium Swz., var. *ensifolium* Baker. (*P. ensifolium* Willd.) Specimen numbered 3,803, ticket 3,821.

On trees, barranca of Las Canoas, Aug. 1891.

P. heteromorphum H. & Gr. (*P. variabile* Mett.) 4,145.

A slender and remarkably beautiful Polypodium, with long narrow perennial fronds that increase in length annually, each season's growth being distinctly seen, so that a single frond may have upon it passé, matured and maturing lengths with the apex preparing for the next season's extension. Found "hanging from fissures in sheltered niches and grottos of cold cliffs," summit of Sierra de Las Cruces, 11,000ft altitude, Sept. 11, 1892.

P. lepidopteris Kze. 5,359.

On trees, hills of Patzcuaro, July 16, 1891.

P. Martensii Mett. 5,360.
With 5,359. Aug. 3, 1892.

P. pectinatum L. 3,974. A form apparently identical with *P. Paradisæ* L. & F.
Rich woods, hacienda de Tamasopo, Dec. 11, 1891.

P. petiolatum, n. sp. 4,001.

Rootstock stout, half an inch or more in diameter, wide-creeping, and thickly clothed wlth large fulvous (brown) scales: fronds scattered, 2^{ft} or more tall, 15 to 18^{in} broad, pinnate; stipites stout, 6 to 8^{in} long, and (as well as the long stipiform rachises) straw colored, smooth and glossy; lamina divided into from sixteen to twenty pair of long acuminated inear-lanceolate pinnæ 6 to 9^{in} long, three-eighths to one-half lan inch broad, stalked nearly to the top, uppermost sub-sessile, the long terminal one with a pair of small sessile pinnæ below; texture sub-coriaceous, smooth; venation that of Goniophlebium, areolæ uniserial, veins conspicuous, sori prominent, thirty to forty each side of the prominent costa.

On mossy oak, Las Canoas, Aug. 19, 1891.

Mr. Pringle wrote me that this fern "was found on the branches of oaks on the mountain sides about the station of Las Canoas in the eastern part of the state of San Luis Potosi. This must have been near the limit of its distribution —certainly on the western limit and near the dry region where ferns cannot grow on trees—for I searched somewhat widely and found only the two specimens." A very distinct and fine Polypodium.

P. Phyllitidis L. 5,187.
On trees, Tamasopo, Dec. 1, 1891.

P. pilosissimum Mart. & Gal. 4,288.
Mossy rocks, Sierra de las Cruces, 11,000^{ft}, Sept. 11, 1892.

P. Plumula. 3,999.
On ledges, Tamasopo, Dec. 1, 1891.

P. vulgare L. 5,190.
Sierra de las Cruces, 11,000^{ft}, Sept. 11, 1892.

TRICHOMANES.

T. pyxidiferum L. 3,800.
Mossy rocks, Tamasopo Mts., July, 1891.

I have referred Mr. Pringle's specimens to this species merely because I do not find any authentic record of *T. filicula* from this continent.

In the note under *T. filicula* in Synopsis Filicum, Dr. Hooker stated that "he could not distinguish from that species a Mexican plant from Liebmann though labelled *pyxidiferum* on high authority," and I am myself unable to discover any important difference between Mr. Pringle's specimens and some specimens of *T. filicula* which I have from Leprieur's Herbarium (Paris Museum) given to me by Dr. Gray. It is doubtful if the two species are in reality distinct.

T. radicans Swz. 5,535.

Wet cliffs, cañons of Colima Mts., May 23, 1893.

Specimens somewhat larger and coarser than our southern form, but otherwise characteristic.

WOODSIA.

W. mollis J. Smith. 1,865.

Moist banks and ledges near Guadalajara, Nov. 1888.

Should have been included in my previous notes, as should also my acknowledgments to Prof. L. M. Underwood for valuable assistance in verifying some determinations at a time when I was greatly troubled with my eyes, and it would seem to me that I was taking to myself credit for what was not justly my due if I continued my notes without putting myself on record in this manner.

In addition to the foregoing ferns several other species previously recorded were again collected, mostly in, or near the same localities as before, so that it does not appear necessary to record them again here.

ERRATA.

Prof. Underwood has called my attention to Mr. Pringle's 1,441 sent out with the collection of 1887 as *Notholæna candida* (see Fern Notes in *Bulletin* Torrey Bot. Club), which he finds to be *Cheilanthes farinosa* Klf. I fully agree with him and thank him for the correction.

He also writes that his specimens of 449 and 1,959 (see also *Bull.* Torr. Bot. Club) are *Cheilanthes Alabamensis* rather than *C. microphylla*, the species to which I had referred those numbers. My own specimens were somewhat intermediate in character, but with, as I still think, a stronger leaning to-

ward *microphylla* than *Alabamensis*. They are as good *microphylla* as many specimens so named by good authority. It does not, however, matter very much from my point of view, as I consider the two so-called species mere forms of one. That they do run into each other through almost inseparable gradations there can be little question, and Prof. Underwood himself appears to doubt their being distinct.

It is certainly impossible at times to separate specimens satisfactorily, and their variations have not only been made the basis for several untenable species but the two extreme forms have even been put into separate genera.

Dr. Hooker, however, in Species Filicum expressed the opinion that we might "conceive of *C. microphylla* having reached its extreme northern limits in the *C. Alabamensis* of the southern states." I coincide with this view and believe that we should write:

Cheilanthes microphylla Swz.

β. var. *Alabamensis* (Buckley). (*C. Alabamensis* Kze.)

Medford, Mass.

Notes on Cribraria minutissima and Licea minima.

GEORGE A. REX.

Cribraria minutissima Schwz.

There is a marked discrepancy between the original description of this species by Schweinitz[1] drawn from the type specimens now in the Schweinitzian herbarium in the Academy of Natural Sciences of Philadelphia, and the later descriptions of Rostafinski and Massee which were drawn from the Schweinitzian specimens in the Berkeleyan herbarium.

The two specimens apparently differ in important points. The diagnostic description of Schweinitz, however, accurately describes the curiously shaped elongated sporangia of the type, which appear as if ellipsoidal when first developed, becoming finally constricted in the middle when mature. The sporangia have the appearance of being girt by a thread, expanding above and below into two nearly equal globose portions, the diameter at the central constriction being from one-half to three-fourths the diameter of the upper and lower portions. A longitudinal section through the center of a typical sporangium suggests the outline of the figure 8, as was aptly stated by Schweinitz in his description.

Below the constriction, the sporangial wall forms a permanent calyculus, but above, it expands into a globose network of band-like threads only occasionally wider at the intersections, and forming irregular meshes.

The Berkeleyan specimen, on the contrary, is described as having no permanent wall or calyculus, but simply a permanent globose network of the same character as that of the typical specimen.

The marked central constriction found in the type specimens is not, however, a fixed character, according to the observations of the writer, who has seen associated both constricted and unconstricted ellipsoidal sporangia, the latter approaching very closely the obovate sporangia of *Cribraria microscopica* B. & C.

An important point necessary to be considered in this con-

[1] De Schweinitz, L. D., Synopsis Fungorum in America Boreali media degentium. Proc. Am. Philos. Soc. 1831. [Philadelphia.]

nection is the relation of *C. microscopica* B. & C. to the two foregoing Schweinitzian forms. In their spores and network these three forms essentially agree. They vary only in the shape of the sporangium, which is a diagnostic character of no specific value, and in the size or degree of development of the calyculus which must be conceded to be variable and therefore a specific character of doubtful value.

The only species of Cribraria created solely upon the absence of a calyculus as a determining specific factor is *C. dictydioides* Balf.; but the great variability in the size of the calyculus in different gatherings and even in the same gathering of the allied and overlapping species *C. tenella* and *C. intricata* makes the validity of *C. dictydioides* more than doubtful.

Sporangia without calyculi associated with others having minute disciform calyculi are constantly found with the typical net characters of both the above species. The same variability of the calyculus is also found, though to a much less extent, in sporangia of the type of *C. vulgaris* Schrad.

As *C. microscopica* B. & C. differs from typical *C. minutissima* Swz. only in having globose or slightly obovate instead of ellipsoidal sporangia, the writer concludes that it is not specifically distinct, but should be merged in *C. minutissima* Swz. which is the older species.

The Berkeleyan form of *C. minutissima* Swz. holds the same relative position to the type as *C. dictydioides* to *C. intricata* and *C. tenella*. It is a constant variety of *C. minutissima* and could only doubtfully be assigned a separate and valid specific place.

The localities for this species known to the writer are Fairmount Park, Phila.; Shawangunk Mts., N. Y.; Newfield, N. J. (J. B. Ellis); and the original station at Bethlehem, Penn. (Schweinitz). The Berkeleyan variety is probably more frequently found than the typical form.

In the preparation of the preceding notes the writer examined and compared the type of *C. minutissima* Swz. in the Schweinitzian herbarium, with an authentic specimen of *C. microscopica* B. & C. communicated by Dr. Curtis, the collector and one of the authors of the type, to the herbarium of the Academy of Natural Sciences, Philadelphia, which corresponds absolutely to the descriptions of the type by Rostafinski and Massee and is probably a part of the same gathering. Specimens from several private collections, illustrating the Berkeleyan variety, were also examined.

Licea minima Fr.

This obscure and little known species has an interesting developmental history.

The sporangia of the American, like those of the European specimens, vary in color greatly. All, except one, of several gatherings from various American localities examined by the writer were of various shades of chestnut or umber brown. In the exception, the color of the sporangial wall was dull black by reflected light, but dark reddish brown or black by transmitted light.

The upper surface of the sporangia in all of the gatherings, was divided by seams or ridges into from four to six parts. In the brown specimens these seams were of a darker brown than the adjacent parts, but in the black specimens they were jet black, smooth and shining. They extend from the base to the center of the surface of the sporangia when of the usual depressed hemispherical form, but to a short central or apical ridge when the sporangia are elongated. These ridges are sutural in character and mark the lines of the rupture of the sporangia upon the dispersion of the spores. The rupture takes place through the middle of the sutures and the resulting segments of the sporangial wall become partly reflexed, thus giving a serrated margin to the cup-like sporangial cavity left by the scattered spores.

The location of these sutures is indicated early in the development and differentiation of the sporangia from the plasmodium.

This fact the writer was able to verify while observing the very interesting development of the sporangia of the black form.

When found, the plasmodium had just entered the first stage of differentiation and had formed cushion-shaped masses of a uniform dull yellow color, probably two and three times the diameter of the mature sporangia. As the development and maturation advanced, the plasmodic masses diminished correspondingly in size, and in the smooth yellow plasmodium the sutures characterizing the mature sporangia began to differentiate, first as double rows of minute dark garnet colored pigment points which gradually grew larger and darker and finally blended, forming black shiny sutures at maturity. While the sutures were developing, the whole sporangial surface also changed from yellow to dark garnet, and finally

black, the pigmentation commencing at the sutural and basal lines and spreading thence toward the centers of the segments of the sporangial wall. The lines of rupture occurred between the rows of pigment points which first outlined the sutures. On examination of the matured sporangial wall under proper microscopical conditions of light and high amplification, a marginal line of rounded cells, varying in degree in different specimens, may usually be seen following the outline of the segments and marking the position of the primary sutural points or foci of pigmentation.

This species will probably be found to be as widely distributed in the northern United States as in northern Europe, where only it has yet been recorded. It was recorded by Schweinitz in his herbarium and in his synopsis of North American fungi under the name of *Licea pusilla* Schrad., with which species it is probably often confounded.

The writer is indebted to the courtesy of Arthur Lister, Esq., of London, for the identification of his specimens with authentic specimens of the species.

The American localities for this species, known to the writer, are Philadelphia, Pa.; Adirondack Mts., N. Y.; and Newfield, N. J. (J. B. Ellis).

Philadelphia, Pa.

E. Strasburger

BOTANICAL GAZETTE, 1894. PLATE XXXI.

THE
JOHN CRERAR
LIBRARY

Eduard Strasburger.

JAMES ELLIS HUMPHREY.

WITH PORTRAIT—PLATE XXXI.

No name has been more familiar to botanists during the past fifteen years and no work has attracted greater attention or contributed more to the progress of our science than that of Eduard Strasburger. Therefore it has been thought that American botanists may be interested in a brief sketch of the man by way of supplement to what they already know of his work. The time is yet, we trust, far distant when any complete account of his life and work will be possible. But it seems legitimate to recognize the interest which naturally attaches to the personality and surroundings of every leader of thought. The following pages are simply the record of the permanent impressions remaining to a student after several months of daily intercourse, begun with no knowledge of the man but such as may be gained from his published work.

Eduard Strasburger is a native of Russian Poland, and has just completed his fiftieth year. He is, therefore, in the prime of his powers. He was educated at Warsaw and in Germany, and showed such promise as a young man that he was called at the age of twenty-five to the university at Jena. There he remained until 1881, when he accepted a call to Bonn as the successor of Hanstein; and none of the calls since received has tempted him from this congenial post. Later he was given the title "Geheimer Regierungsrath," the official distinction which the Prussian government confers upon its citizens of profound scholarship or other great attainments.

The results of his researches during the past twenty-five years are recorded in about as many published papers and volumes, familiar to botanists everywhere. In looking over the chronological list one is struck by the homogeneity of the work, and a little examination affords striking proof of that development of one research from a previous one, so characteristic of the greatest investigators. Entering upon a field which had shortly before been shown by the path-breaking work of Hofmeister to be so full of interest and far-reaching significance, the reproduction of the gymnosperms, he was naturally led to the comparative study of the angiosperms

also, and, one question leading to another, deeper and deeper into the investigation of the processes involved in the reproduction of the flowering plants, and of their significance. These studies naturally and early led to the investigation of the cell-contents, and especially of the nucleus, whose fundamental importance in the activity of the cell becomes so quickly apparent to the student. And it is perhaps through his work upon the indirect division of the nucleus that his name is most widely known. Prof. Strasburger himself states that his attention was first attracted to the karyokinetic figures by their conspicuousness in the endosperm of certain Coniferæ, and their superficial resemblance to the figures formed about the poles of a magnet. Studies of the cell contents inevitably brought up also questions as to the structure and growth of its wall. Apart from the two related lines of research just indicated, his chief work has been that which has resulted in his classic volume on the structure and functions of the vascular bundles in plants, which is also the bulkiest of his publications; so that he always refers to it in conversation as "Mein grosses Buch."

Just outside the corporate limits of Bonn, in the suburb of Poppelsdorf, stands the "Poppelsdorfer Schloss," up to the beginning of the present century a summer palace of the Archbishop-Electors of Cologne. It is a huge square building of two stories, about a central circular court, and is occupied by the Natural History department of the university, containing also the residence of the professor of botany. The botanical establishment occupies the entire upper floor of the southeasterly side of the square, and more than half of that of the northeasterly or front side. The fact that the building was erected in the first half of the last century, and for quite another use, will explain why it is poorly adapted for laboratory purposes. Yet, since the windows are large, and one finds abundant room and all necessary apparatus, he has no reason for complaint. The Botanical Institute includes a lecture room, well supplied with wall charts and diagrams, a laboratory for elementary and one for advanced students, and private rooms for the professor extraordinarius, Prof. Schimper, and for the assistant, besides storage room for apparatus, reagents and alcoholic material.

Prof. Strasburger devotes the two rooms of his residence which adjoin the institute to his own work, one serving as

library, the other as laboratory. These rooms are simply furnished, but their contents show that their occupant denies himself nothing that can really aid his work; and their scrupulous neatness and orderliness mark him as a careful and systematic man. Everything has its place and is to be found there when not in use. The library is very complete in modern botanical literature, and the space required for the alphabetical classification of the pamphlets, chiefly authors' reprints, is calculated to impress one with the volume of the literature of botany. Perhaps nothing serves to give a better idea of the rate at which this volume is increasing than a glance through the undistributed accumulation of two or three months on a shelf here.

The principal windows of the professor's residence and of the laboratories overlook the old palace garden, which has been the botanic garden since the foundation of the university in 1818. This is well laid out and well stocked. The out-of-door part has thus far received the chief attention of Prof. Strasburger, who is *ex officio* its director. This consists of an open level plot, laid out in beds for the systematic display of the vascular plants, and bordered at one end by a small pond which is formed by the widening of a part of the old palace moat and gives suitable ground for aquatics and swamp plants. On each side of the "system" lie the two parts of the arboretum, which contains many large and fine trees, including not a few American species. I noted large and flourishing specimens of *Quercus rubra*, *Juglans nigra*, and *Liriodendron tulipifera*, among others; while the blooming of our red maple was almost the first tangible evidence that the dreary drizzle that passes for winter in the Rhine valley was giving place to spring. The garden is rich in conifers, as the inspector, Herr Beissner, is a leading authority on this group. One of the oldest and most striking of them is a beautiful cedar of Lebanon, which is quite hardy there. There are also sections for officinal plants and poisonous plants, and a biological section where one finds grouped together in one bed plants which have solved a given biological problem in a similar way, without regard to natural relationships. This section was laid out under the present director and was one of the first of its kind in Germany. Most gardens now give more or less attention to such an arrangement, whose value is too evident to need emphasis. The

greenhouses, though partly old and in poor condition, contain some interesting things. Strikingly good are some large aroids and cycads and two tubs of splendid plants of *Strelitzia Reginæ* that produce every spring thirty or forty flower-stalks, and, after artificial pollination, develop good seeds. The palm-house and *Victoria*-house are new and good, and there is always something interesting to be seen in the propagation houses.

So much for the place where his work is done. Personally Prof. Strasburger is spare in figure and above the medium height, but his devotion to the microscope has given to his shoulders the student's stoop in a marked degree. His serious face and deep-set penetrating eyes can light up most pleasantly, as at the moment when the accompanying excellent likeness was taken.

In the lecture room he speaks very distinctly and earnestly, and presents his subject in clear and attractive fashion. He throws his whole thought and energy into the matter in hand, often showing deep feeling, and impressing the most careless hearer with his own profound belief in the interest and importance of what he presents. A lecture of three quarters of an hour is thus often very exhausting, but it cannot be doubted that its influence on the audience is far more real and lasting than that of a speaker of less enthusiastic temperament. In the laboratory the same qualities are prominent. His real interest in the work of each student, hearty appreciation of good work, and pressing curiosity for new facts stimulate all to their best efforts. The earnest student does not require much time to discover that no books, no piece of apparatus, no plant in the whole establishment, which can facilitate his work will be withheld. Should he feel hesitancy in asking often for apparatus which is private property, or in mutilating a rare plant, he is met by the question: "What is it here for?" This geniality and generosity in the interest of his science is thoroughly characteristic of Prof. Strasburger. Earnestness is the sure passport to his fullest aid and sympathy, and is assumed in every new comer until he has shown the contrary.

In his private work he is eager, persistent, indefatigable. Looking at a subject from every side, following up every clue, welcoming evidence from every source, and with a really extraordinary capacity for accomplishing results, one who

knew only the man could prophesy the quality of his work. One recognizes qualities of the ideal investigator in his zeal for the truth, no matter whose theories suffer, his openness to conviction, and his freedom from petty jealousy. He has pronounced views on disputed questions, and decided opinions of the work of others; yet one soon comes to feel that there is none of his views that cannot instantly be given up, and none of his opinions that cannot be modified when the accumulation of evidence shows it to be necessary. If he sifts evidence most critically and demands that it be ample, one feels so much the more confidence in his conclusions.

His quick, nervous manner is in marked contrast to the usual phlegmatic calmness of the native German, and is sometimes brusque to the verge of abruptness. But one quickly learns that this is but the expression of his intense earnestness and concentration upon the subject in mind, to the exclusion of all non-essentials. Finally, one's admiration daily increases as his marvelous grasp of the whole field of morphology and physiology is brought out by the discussion of the problems constantly arising in the laboratory. One recognizes a growing consciousness of the presence of a master mind, and a growing delight in contact with it. It is the possibility of the free development of such minds and of the fruition in them of the true scientific spirit in an atmosphere of complete "Lehrfreiheit und Lernfreiheit" that constitutes the chief glory of the German university.

Weymouth Heights, Mass.

Noteworthy anatomical and physiological researches.

Physiological action at a distance.

Dr. Elfving has published an additional paper[1] concerning the effect of different bodies upon the sporangiophores of *Phycomyces nitens*. Errera (see BOT. GAZ. **18:** 196. 1893) explained the attractive or repulsive effect of different metals, etc., upon the organs named as manifestations of hydrotropism in the latter. Elfving now publishes new experiments. If iron acts as a hygroscopic body upon the negatively hydrotropic sporangiophores, we may expect to see the phenomenon most plainly when the fungus is exposed to the influence of such highly hygroscopic bodies as calcium chloride. The result was, however, negative.

A very hygroscopic plate of gypsum ($80 \times 35 \times 10^{mm}$), dried at 100° C., and placed among the sporangiophores in an atmosphere saturated with water, had no effect whatever upon these. [To those who have done experimental work with hydrotropism, this is no wonder, since there was no hygroscopic variation to act upon the sporangiophores. Errera says, however, that a hydrotropic organ bends towards a place "not where it will find a maximum or minimum of moisture, but where it will, within certain limits, transpire most or least;" on the other hand, he asserts, that the movements or streaming of the molecules in the air is the source of hydrotropic irritability. The first statement is contradicted by the experiments of Du Hamel, Knight, Johnson, Dutrochet, Duchartre, Sachs, Pfeffer, and Molisch.] This gypsum plate condensed 1.665^{gm} of water. An iron plate (surface of 4950 $^{sq.\ mm}$) had a well marked attractive effect, and condensed only 3.5^{mgm} of water.

Elfving comes to the conclusion that these phenomena are caused by molecular movements. Highly polished steel and platinum have very little effect upon the sporangiophores, but if these metals are exposed to direct sunlight for a long time they become active, i. e., they are brought into such a condition that they attract said organs. This active condition only lasts for some hours, and then it disappears.

[1] Zur Kenntniss d. pflanzlichen Irritabilität.—Sep. from Oefversigt af Finska Vetensk. Soc. Foerh. Haeft 36. 1893.

We know that a number of non-phosphorescent bodies emit rays of light after having been under the influence of the latter. The duration of this condition is from a few minutes to twenty-four hours. Metals like steel and iron are non-phosphorescent, but we have here a new form of this phenomenon, dark phosphorescence. It is the light, and not the heat which produces the effect named upon the metals; the color of the rays does not seem to have any power to produce in the metals the effect described above. Zinc becomes active by heating alone; when experimenting with this body, Elfving found that it acts as a positive thermotropic agent. On copper, cobalt, nickel, tin, lead, and glass, heating (as above) alone did not produce the activity, although these metals and the glass were heated until they were nearly melting, and then allowed to cool so far that the hand could not feel the heat.

Elfving concludes: "Es scheint mir dann wenig befremdend anzunehmen, dass auch Molekularschwingungen, welche den Körpern selbst innewohnen, oder irgend eine in denselben stattfindende Veränderung begleiten, ähnliche physiologische Wirkungen hervorrufen können. Was speciell die Metalle betrifft, zeigt uns ja auch die Metallotherapie Wirkungen, die entschieden für solche sprechen."—J. CHRISTIAN BAY.

Color bodies in seeds and seedlings.[2]

In this paper Famintzin gives the results of his investigations on the origin of chlorophyll in plants, a subject concerning which there is much uncertainty and difference of opinion, as may be seen in the fact that Bredow and Belzung who studied this question came to diametrically opposite conclusions.

Famintzin's attention was directed principally to the ripe seeds of Helianthus. Microtome sections were placed in Helianthus oil, whereby colorless choromatophores, 1.5–2.5μ in diameter, were distinguished without further treatment, although their presence was more easily discernible when the sections had been slightly moistened with the breath. The chromatophores are situated partly in the spaces between the aleurone grains and partly on the surface of the latter and upon the cell nucleus.

[2] FAMINTZIN, A. Ueber das Schicksal der Chlorophyllkörner in Samen und Keimlingen, 16 pp., 1 plate. Arbeiten des botanischen Laboratoriums der Akadamie, St. Petersburg, 1893. No. 5. Abst. in Botan. Centralbl. **58**: 378–9. 1894.

Their presence in all of the embryo cells may be demonstrated by treating the embryo with acid fuchsin, the chromatophores and a thin layer of plasma surrounding the aleurone grains taking the stain. This demonstration is facilitated by previously treating the sections with acetic acid which causes the aleurone grains to swell and finally to dissolve.

The swelling of the aleurone grains take place normally in the early stages of germination, producing a similar effect as when treated with acetic acid.

The chromatophores are frequently found closely pressed together in groups of considerable size which are liable to be mistaken for single bodies.

In germinating seeds the colorless chromatophores may be easily made out by the acid fuchsin stain. The author discovered a further means of distinguishing them in resting as well as germinating seeds by the use of ammonia, an alkali, or alkaline carbonate. The chromatophores were found to contain chromogen which, by means of these reagents, was transformed into a golden-yellow pigment. If thin sections of the Helianthus seeds are placed in a moist chamber with access of air, the chromatophores, owing to the presence of chromogen, become spontaneously colored, taking on at first a bluish-green, and later a yellowish-brown tint.

A comparison of sections of ripe seeds with those of seedlings of different ages, including those containing chlorophyll-green chromatophores, showed all stages of transformation so that it is not to be doubted that the chlorophyll grains of the seedling arise from the colorless chromatophores of the seed. This result was confirmed by a study of the seeds of Lupinus albo-coccineus.

A later and shorter paper by Famintzin discusses the chromogen of Helianthus seeds. At present the author is engaged in a study of the relations of this pigment to xanthophyll and chlorophyll, both of which are probably derived from chromogen in the process of germination. Unfortunately the original papers are in Russian, hence inaccessible to the majority of scientific readers.—G. H. HICKS.

Investigations on pine and oak wood.[3]

This series of investigations by Dr. R. Hartig, begun in 1891 and completed early in the present year are a continuation of investigations begun many years ago; and they are to be followed by others by the same author dealing especially with the influences exerted by the soil in which trees grow, and the results obtained by growing trees in masses and in the open. While the investigations were conducted in accordance with scientific methods nothing that will be of value to the practical forester has been omitted.

PINE.—The trees studied were grouped in five or six classes according to diameter at a given height above the ground. For convenience periods of ten or twenty years are taken as units, each designated as a growth period. Classes one, two, and three attained the maximum annual growth in height in the growth period between thirty and forty years; class four a decade earlier; class five continued its maximum annual growth nearly twenty years, i. e., from twenty to forty. Class six did not reach its greatest growth until the two periods between forty and sixty years. The last tree had early fallen behind the others in growth and was consequently overshadowed by them. By the time the forest was forty years old class six was so completely shaded that a rapid growth in height became necessary in order to obtain sunlight.

In a pine tree one hundred years old five of the annual rings of wood, within the last twenty years of growth, did not extend down to a point 1.3 meters above the ground; four were lacking at a point 3.5 meters above the ground; two at 5.5 meters; and one at 7.7 meters. Two of these short rings were formed more than ten years before the tree died. This indicates an exceedingly interesting physiological fact, namely that the cambium may remain inactive for years without losing its power of cell-division.

As a result of these and some earlier investigations the author derives his theory for the formation of the annual ring. Briefly stated it is as follows: The wood formed in the early part of the season is composed chiefly of large vessels with wide lumina. These are designated as conducting organs. It is along these that the larger portion of the transpiration stream passes. When a sufficient quantity of conducting tis-

[3]ROBERT HARTIG.—Forstlich-naturwissenschaftliche Zeitschrift. **1:** 129, 169, 209. 1892.—**2:** 49, 249, 289. 1893.—**3:** 1, 49, 172, 193. 1894.

sue has been formed wood composed of smaller, much thicker walled cells is produced.

In pine forests of recent growth the maximum thickness of the annual ring is found in the first ten years. In trees grown in the primeval forest, the maximum thickness is not reached until the one hundredth year; sometimes as late as the one hundred fiftieth or sixtieth. The thickness of the annual ring is greater in the upper part of the trunk than in the lower, excepting in trees grown in the open. This is due to two reasons: First, the action of the cambium begins three or four weeks earlier in the tops of closely growing pines than in the lower parts of the trunks, thus producing a greater number of cells above than below in the season; second, as the nourishment of the tree must pass from the top to all lower parts, the upper part is at all times supplied with a greater quantity of material for cell formation than the lower.

The quality of timber is found to differ very greatly, not only in different trees grown under apparently the same external conditions, but also in different parts of the same tree.

Of the timber from recently grown pine forests, the first formed is the poorest, the value increasing with each year's production. Pine trees growing in the shade, having comparatively little transpiration, and with growth beginning late in the season, have valuable wood from the beginning. Trees grown well up the sides of mountains or in wet localities have the best wood formed early.

The amount of water present decreases from the outer part of the tree to the inner, with a sudden falling off, in passing from sap-wood to heart-wood. The relative amount of alburnum to duramen is not always the same on different sides of the same tree. There may be a difference of as much as ten annual rings. The percentage of shrinkage in heart-wood of pine is much less than that of sap-wood. In comparison it is interesting to note that in the beech the percentage of shrinkage is the same for the old and young trees, for sap-wood and heart-wood, while in the oak the shrinkage is much greater in the sap-wood. The smaller amount of shrinkage in the heart-wood of pine and oak is due to the deposition of the material which characterizes heart-wood, in the micellar interstices of its cell walls.

A difference in size of trees of the same age is very closely related to the difference in size of the elements composing them.

OAK.—The trees used in the work upon oak wood were felled at different times during the season, beginning May 2. At this time, though swelling of the buds was not perceptible, the first large vessels were fully formed. The activity of the cambium had doubtless begun in the last week in April. Activity in this tree had begun in all aerial parts at the same time. On the 6th of June the cambium of the roots one-half meter from the stem was still dormant. By the 21st of June the annual growth of stem was half completed. When compared with the preceding annual ring the thickness of the forming ring was found to vary from .45 to .72. On the 19th of August the formation of wood at the base of the trunk had ceased, in the upper part of the trunk the cells were still thinwalled and unlignified, while in the smaller branches cell-formation was still going on. By the 5th of September the formation of wood had ceased in all parts of the tree. The time required for the formation of the annual ring is thus shown to be a little more than four months, extending from last third of April to the last of August. In this connection the author states that in red beech and pine growth does not begin until about four weeks later, being completed in the pine as early as Aug. 10th, and in the beech but little later, making the time required for formation of an annual ring in the beech and pine about two and a half months.

At the time that shoots and leaves are developing, a complete transformation of the starch in the smaller branches takes place. In the older parts of the tree the starch of the bark (phloem and cortex) is first changed for the nourishment of the cambium. At the beginning of June for a short time all starch disappears from the sap-wood. This disappearance has already begun in the upper part of the trunk by the middle of May. The disappearance of starch progresses inward and downward, and is completed by the 6th of June, only the starch of the roots remaining unchanged. By the middle of June the storing of food in the form of starch has begun in the outer sap-wood layers of the trunk and of branches a few years old. The 1–3-year-old twigs are still without starch. The newer sap-wood is still empty. The youngest wood-ring, on the contrary, shows some starch in the vicinity of the large vessels. Traces of it are also found in the phloem. At the beginning of July all parts of the tree are well stocked with reserve starch. Its accumulation in the phloem has

been more rapid in the upper part of the tree than in the lower. From the beginning of August to the middle starch is entirely wanting in the phloem of the branches. In the phloem of the stem only traces of it are found in the outer part. It is assumed that the starch has been withdrawn from the phloem a second time to be used in the growth of the phloem itself. Not until the beginning of September has the accumulation of reserve food begun again in the phloem, and then only in the lower part of the stem. As late as the 30th of September the bark of the 1–2-year-old twigs is still free of starch, although it is abundantly supplied with it by the end of October. In December the starch has been changed into sugar and oil.

The amount of water in oak wood taken from different parts of the same tree varies considerably. It is very abundant, as a rule, in the outer layers of sap-wood; less so in the inner layers; while the outer portion of the heart-wood is comparatively poor in water with a constantly increasing amount as one nears the center of the tree. Taken as a whole the heart-wood usually contains a larger percentage of water than the sap-wood. The wood of the root-shaft contains more water than that of any other part of the tree. The small roots, however, seem to be poor in water. There is a decrease in the amount of water present in passing from the base of the tree toward the crown. This decrease continues in very old trees to the ends of the twigs. In young trees the diminution is continued to the upper end of bole, but from here to the extremities of the twigs, there is a constant increase. In perfectly air-dry oak wood, to every 100 volumes of the wood substance there are 19 to 20 volumes of imbibition water.

In reviewing the results of his investigations, the author calls attention to one fact of especial interest from a physiological standpoint; the adaptation of the anatomical structure of the wood of trees to their needs as produced by external conditions. The smaller roots, which either do not perform any mechanical function for the tree, or if so, only to a limited degree, contain no trace of mechanical tissue. The larger roots and root-shaft, on the contrary, have so much mechanical tissue that they furnish well nigh the strongest wood of the tree. In these places strong wood is necessary for resisting the force of winds. If for any reason the transpira-

tion of a tree is large in proportion to its conducting tissue, the wood of the tree will be composed largely of conducting and storage tissue; on the other hand, if the amount of transpiration is limited to any considerable degree, less conducting tissue will be required and the tree will have at its disposal a larger quantity of plastic material from which to produce mechanical tissue.—L. S. CHENEY.

Adaptation of African plants to climate.[4]

After some introductory remarks upon the highly interesting flora of Cape Colony, the author describes the different ways in which the plants are adapted to the climate. The variety of arrangements for this purpose is very great and may be considered from different points of view. The evaporation is prevented by reduction of the leaves, either by the development of small leaf-blades, or by transferring their function to green stems. Stapelia, Euphorbia and the imported Opuntia illustrate the last case, while small or narrow leaves are very common, for instance in Bruniaceæ, many Compositæ, and others. Some other plants show the surface of the leaves impregnated with substances that are impermeable to water, and this is to be observed in Aloe, Protea, Myrica and several others. The cuticle, or a cover of wax or silica, forms the protective medium in these plants.

A covering of hairs is also very common, by which the communication between the atmosphere and the air within becomes greatly impeded. Leucadendron, Helichrysum, several Leguminosæ, and Proteaceæ are protected in this way.

Secreted mineral substances may also form a protecting layer over the whole leaf as in Tamarix, or only over the depressions in which the stomata are situated, as in Statice, Vogelia, and other Plumbagineæ.

Such arrangements as the placing of the stomata in depressions or in grooves of leaves and stems, or under the reflexed edges of the leaves are also common in this vegetation.

Eucalyptus globulus and Protea grandiflora illustrate the case in which the leaves assume the most favorable position towards the sun.

There are also plants which possess reservoirs in their stems, rhizomes, or leaves. Such plants are the delicate herb, Ele-

[4] MARLOTH, R.—Some adaptations of South African plants to the climate. Trans. South African Phil. Soc. **6**: 31.

phantorhiza Burchellii, which has a huge watery rhizome, sometimes weighing ten pounds. Several Asclepiadeæ of the Kalahari region accumulate so much water in their tubers that the bushmen often depend entirely on it. The Stapelias and Euphorbias store the water in their stems and retain it with great tenacity. The remarkable Cissus Cramerianus of Damaraland has a large fleshy trunk and develops only a few thick branches.

Too rapid evaporation may also be prevented by sap contents of various composition, as for instance slime, gum or salt. The succulents are protected in this way, gum occurring in the Acacias, salt in Augea Capensis and Zygophyllum Marlothii. The salt is often deposited in such quantities that during the drying of the plant it crystallizes and forms a thick crust on it.

Hairs, glands or sheaths are the organs which enable the plant to absorb the dew. This is for instance the case with Salsola Zeyheri from the Kalahari region, where rain is rare. The depressed glands at the base of the leaves of Acacias seem to serve for the same purpose, for drops of dew running down along the rhachis must moisten them. Watsonia Meriana is protected by the large sheaths, which were found to contain water even many weeks after rain has fallen.

THEO. HOLM.

BRIEFER ARTICLES.

New localities.—The following are some localities for plants, not given in Gray's Manual, 6th edition:

Salsola kali tragus was first found and reported in Illinois, by myt self, at Polo, Aug. 14th. Since then I have found it at Oregon, Savanna, and Chicago. Letters to the Experiment Station also give it as occurring at fourteen other places. At most places it was undoubtedly introduced by cattle trains from the north-west. So far it has been found only in the northern part of the state, and chiefly along the railroads. At Savanna, and possibly at some places in Chicago, this plant undoubtedly occurred last year, as two or three thousand plants were found.

Grindelia squarrosa is given as occurring at Evanston only, in this state. Several specimens of this were found by me at Polo, Oregon, and Savanna. These towns are on the Chicago, Burlington and Northern railroad, and the plants were undoubtedly introduced by that road from the north.

At Savanna a few specimens of *Solanum triflorum* were discovered. This is given in the Manual as occurring in central Kansas and westward. This was also introduced by the railroad.

A single specimen of what appears to be *Verbascum nigrum* was found on the Experiment Station grounds at Champaign. This probably came through seed from Europe, as the plant is not given in the Manual as yet occurring in the United States.—G. P. CLINTON, *Champaign, Ills.*

Two Wisconsin Fungi.—**Uromyces minimus**, n. sp.—Hypophyllous. Uredosori light brown, teleutosori black, oblong or linear, soon naked. Uredospores globose or oval, light brown, echinulate, 12–19μ in diameter, usually 14–16. Teleutospores brown, smooth, spheroidal oval or oblong, 14–22×12–19μ, usually 17–20×15–17μ, apex rounded, conical or occasionally truncate, very strongly thickened, the apical thickening often constituting nearly half the length of the spore; pedicels moderately stout, tinted, once to twice the length of the spore. Colorless clavate paraphyses present.—On *Muhlenbergia sylvatica* Torr. & Gr. Kenosha co., Wisconsin.

In the same station an æcidium occurs on *Cacalia reniformis* Muhl. which differs from the other æcidia on Compositæ and which I have not seen elsewhere, but no experiments have been made to demonstrate genetic relationship.

Doassansia ranunculina, n. sp.—Spots light brown, 2–4^{mm} in diameter, papillate. Sori aggregated or scattered, usually spherical, 100–200μ in diameter, developing in either the parenchyma or the palisade layer of the leaf or in any position in the petiole between the epidermis and the fibro-vascular bundles. Spores crowded, filling the sorus, spherical or polygonal, 6–10μ in diameter. Cortex of one layer of cells which are more or less quadrangular in section, 10–15×8–12μ. Spores germinating in position. Promycelium 3–4μ in diameter, vacuolate. Primary sporidia 6–8 in a whorl on the end of the promycelium, fusiform, vacuolate, 12–20×2–2.5μ. Conjugation by means of a large apical tube both in position and after becoming free. A filament 60–90μ long is then formed from which the secondary sporidia are abstricted in basipetal succession. Secondary sporidia 12–15× 2.5–3μ. In material which had germinated and produced the filaments in the field the secondary sporidia conjugated by means of connecting tubes. In many of the specimens collected germination had occurred and the filaments protruded through the cleft cortex and epidermis.

In the leaves and occasionally the petioles of *Ranunculus multifidus* Pursh, in swampy places which had become dry during the summer. Racine, Wisconsin.

Material has been prepared for the distribution of these species in Ellis and Everhart's North American Fungi.—J. J. Davis, *Racine, Wisconsin.*

Ruled slides.—For several years I have made much use of ruled slides with a stage microscope. It is so easy thus to measure any thing you dissect, that I wonder they are not in more general use. Those I use are ruled in squares, 10^{mm} each way, in the middle of a slide which ought to be three inches long, and wider than the ordinary slide to prevent getting mixed up with them. The ruling ought to be deep enough so that water will not temporarily make it impossible or very difficult to see the lines. Good ruled slides for the use above named ought to be in the market at moderate prices.—W. J. Beal, *Agricultural College, Mich.*

CURRENT LITERATURE.

The evolution of plant life.[1]

Another book intended as a University Extension manual has recently come to our notice. In these days when college men are eagerly looking for books suitable for interested intelligent but uninstructed people to read—books which will give a connected idea of plant forms and their activities—any title which promises as much as the above will attract attention. But when attention is directed to the book, few, we think, will be able to detect the appropriateness of the title. Instead of discussing the evolution of plant life the author gives us an account of the various groups of plants, with a single prefatory chapter on life, protoplasm, adaptability, division of labor, the cell, tissues, and similar general matters. The remaining chapters on Mycetozoa, Thallophyta, Lichenes, Characeæ, Muscineæ, Pteridophyta, and Phanerogamia, form essentially a much abbreviated textbook on morphology, whose faults, while chiefly those of abridgement, are too often due to confused ideas of homology.

Mr. Massee's statements are often obscure, and this obscurity appears to be traceable sometimes to his ideas and sometimes to the inappropriate phrases chosen to convey his ideas. The definition of metabolism (p. 41) illustrates the former case, and such a phrase as "protection against climate" (p. 18) the latter. In discussing the evolution of sexuality (p. 66) the author goes far astray. Having mentioned examples of conjugation he adds:

"In these examples the greater part of the protoplasm is used up in the formation of the reproductive bodies; but as differentiation in this direction proceeds, we observe that the relative bulk of the individual specialized for reproductive purposes becomes less and less, until we reach Phanerogams, where *the parts concerned in the process, stamens and ovules, or young unfertilized seeds*, usually bear a very small proportion [*sic*] to the whole; and yet in the fertilized seed we get a concentration of all that is required to evolve, under favorable conditions into an individual like the parent form."

This confusion of ideas regarding sexuality in phanerogams and cryptogams continues throughout the entire book, most strikingly on pp. 68, 69, 74. It is so prominent as to excite some wonderment as to where the writer has been these last ten years. It must have been a spot remote or secluded, for we are assured (p. 74) that "the most

[1] MASSEE, GEORGE:—The evolution of plant life, lower forms. 12 mo. pp. viii, 242 figs. 38. London: Methuen & Co. 1891. 2sh. 6d.

generally accepted primary division of the vegetable kingdom at the present day is into the two divisions formed by Linnaeus" [i. e., Cryptogams and Phanerogams].

With the bulk of the descriptive part of the book less fault can be found; but surely a writer of a university extension manual ought to take the greatest care not to propagate false conceptions of homologies so fundamental as those dealt with above. The book presenting modern views of plant life and adapted to popular reading remains yet to be written in English.

The essential oils.

The chemistry of plant products, as well as their mode of origin, is always a matter of interest to physiologists. When these products are of economic importance, either medicinally or industrially, interest attaches also to their commercial source. Schimmel & Co. of Leipzig and Prag have long made a specialty of one group of such substances, viz., essential oils. A few years ago they established branch laboratories in this country at Garfield, N. J., in the name of their agents, Fritsche Bros., and placed it under the direction of Dr. Frederick B. Power, one of the best known pharmaceutical chemists in this country. Dr. Power has recently compiled a descriptive catalogue of essential oils and organic chemical preparations,[1] which embraces, in a systematic and comprehensive form, and in alphabetical arrangement, not only all the official and ordinary essential oils met with in commerce, but also a large number of rarer products which have been prepared at various times for strictly scientific or experimental purposes. In connection with each article the botanical source, physical characters, and chemical composition are given, with other special tests for purity when such are known.

The work is divided into three parts, comprising (*a*) the official essential oils, or those recognized by the U. S. Pharmacopœia of 1890, together with some closely related oils, (*b*) the non-official essential oils, and (*c*) organic chemical preparations.

The work is concise in its character, contains a considerable number of references to publications embodying the more important original investigations, and the endeavor has been made to present an accurate record, up to the date of publication, of all the well-substantiated facts relating to the characters and composition of the oils and chemical preparations considered in the work.

It is designed for reference chiefly, and will be found useful to all who are either commercially or scientifically interested in the subjects of which it treats.

[1] Small 8vo. pp. 96. New York: Fritsche Bros. $1.00. To be purchased through B. Westermann & Co., New York.

A compendium of general botany.[1]

This book is really a wonder considered from a literary standpoint. It is neat, precise and up to date. One is surprised to find how much has been condensed in so little space. The author has intended it to serve as a guide to the German high school pupils. It ought to serve a similar purpose in this country, but according to the present curriculum of studies it will be found very useful in our colleges and universities.

The arrangement of the subject matter is scientifically correct. Part I, comprising forty-two pages, treats of the cell, part II of tissues and single organs, part III of systems of organs, part IV of reproduction. This is the most interesting part. Here are explained and compared, as in no other textbook, the rotation of gametophytic and sporophytic generations in mosses, vascular cryptogams and phanerogams. Part V treats of the physics and chemistry of plant life, and part VI, comprising six pages, of plant classification.

The author's style is simple yet clear, and scientific. It is not intended as a book for "recreative" reading. The chapter on the general physiology of reproduction is perhaps too deep for the average high school pupil.

The original figures are excellent. The others are well selected from the works of the best authors.—A. SCHNEIDER.

Minor Notices.

THE FOSSIL PLANTS of the Bozeman, Montana, coal fields are listed, with annotations, by Mr. F. H. Knowlton in bulletin 105, U. S. Geological Survey.

PROFESSOR A. S. HITCHCOCK'S "Key to spring flora of Manhattan, [Kansas]" is intended to enable beginners to name the angiosperms of that vicinity.

DIRECTIONS FOR DESCRIBING a flowering plant, i. e., a "scheme for plant analysis", based on Gray's "Lessons," have been prepared by F. L. Sargent and published by the Cambridge Botanical Supply Co.

A LIST OF the Sphagna, parasitic fungi, and liverworts, collected by Mr. L. S. Cheney in the course of the prosecution of a botanical survey of the Wisconsin river valley, has been separately issued in advance of the publication of the tenth volume of the Trans. Wisconsin Academy. The list will accompany the sets of specimens as distributed.

[1] WESTERMAIER, MAX.—Kompendium der allgemeinen Botanik für Hochschulen. 8vo pp. 309. figs. 171. Freiberg in Breisgau: Herder'sche Verlagshandlung.

EFFECT OF SPRAYING with fungicides on the growth of nursery stock is the subject of a bulletin (no. 7) from the division of vegetable pathology of the U. S. Department of Agriculture. In general much and valuable improvement showed in such plants by application of fungicides, especially of Bordeaux mixture, and particularly with pears, cherries and plums.

THE NINTH NUMBER of the *Minnesota Botanical Studies* contains three articles. Two of them describe newly devised physiological apparatus, and the third is a bibliography of the subject of the fixation of free nitrogen by plants. The last is by D. T. MacDougal, and embraces over 600 titles. It is proposed to issue a second installment of titles after a time. The apparatus has already been mentioned and also advertised in this journal. Both the auxanometer with its continuous recorder, described by the inventor, W. D. Frost, and the registering balance, also described by its inventor, Alex. P. Anderson, are most excellent instruments, and must prove of great service to investigators and to teachers. Both instruments, of which plates from photographs are given, can be bought at a reasonable price.

THE ANNUAL REPORT of the New Jersey Experiment Station for 1893 includes the report of the botanist, Dr. B. D. Halsted, occupying 150 pages, with 73 illustrations. This part has also been distributed as a separate. The number of topics treated by Dr. Halsted is very large. Most of the illustrations are from photographs by the author. Altogether it shows great industry on the part of the writer, and a sharp eye for interesting matters of observation. Most of the report is upon fungous diseases of plants, of which a great variety are treated, many being of the nature of spot diseases.

Only a small part of this report is now published for the first time The author has brought together in convenient form the result of his labors for the year, reprinting all papers which had previously appeared. We see no reason, however, why the author should not have followed the usual custom of giving credit to the journals to which he is indebted. In some instances this is done, but we notice articles taken from the *American Florist*, the *Proceedings of the Society for the Promotion of Agricultural Science*, and others, for which no credit is given. This is not only an infringement of a well grounded custom, but it makes it difficult for conscientious writers to properly cite such articles.

The report embraces much admirable work, but it must be a regret that bibliographical details were not more carefully looked after.

THE SECTION Harpidium of the genus Hypnum was elaborated for the Muscologia Gallica by Mr. F. Renauld. These pages have been issued as a separate.[1] M. Renauld's wide knowledge of these forms, very careful descriptions, and critical remarks under the more obscure species will be of great assistance to students of this very difficult group.

THE UNCULTIVATED bast fibers of the United States are treated in a bulletin (no. 6) issued by the U. S. Department of Agriculture in its series of fiber investigations. It has been prepared by C. R. Dodge. A score or more of species find place in the list, including the common and well known plants: Hibiscus Moscheutos, Abutilon Avicennæ, Asclepias incarnata, Apocynum cannabinum and others.

IN A preliminary paper on Nucleolen und Centrosomen in the *Berichte* d. deutsch. bot. Gesells. **12**: 108–117. *pl. 6.* 1894,[2] which has been distributed as a separate, Dr. J. E. Humphrey shows that the nucleolus can not be regarded as an organ of the cell, since the extrusion and persistence of nucleolar substance during nuclear division is not normal but exceptional and probably pathological. He thinks the nucleoli inactive globules of fluid or semi-fluid substance. The paranucleolus of Strasburger, a crescentic body found often at one margin of the nucleus, is due to faulty fixation methods. He also finds centrospheres in Psilotum and Osmunda.

WE HAVE received the second edition of the voluminous catalogue of the library attached to the botanical garden of Buitenzorg, Java, of which Dr. Treub is the director. This classified catalogue, arranged under each topic alphabetically by authors, is intended chiefly for the use of the garden staff and visiting botanists. It forms a bulky volume of 371 very large octavo pages (18×26^{cm}). The number of titles is not given, but it may be roughly estimated as between 4,000 and 5,000. A table of contents shows the classification adopted and a full index to authors renders reference very easy. Copies of this catalogue may be obtained gratis by addressing the director.

[1] Musc. Gall. **2**: 368–395. *pl. 105–113.* Mr 1894.
[2] See also Annals of Bot. **8**: 373-375. S 1894.

OPEN LETTERS.

Comment on "The meaning of tree life."

When Professor Greene, in reviewing Professor MacMillan's Metaspermæ of the Minnesota Valley, said that it would prove useful to those who knew how to use it, he can hardly have had reference to the sort of use which appears to have been made of a portion of it by a recent writer in the *American Naturalist.*

In that portion of his work entitled "Relationship of the Metaspermic Flora of the Minnesota Valley," Professor MacMillan has given a careful and elaborate discussion of the causes, past and present, which have determined the character of the region under consideration. In the course of this discussion, he devotes a section to "Outlines of Metaspermic History in the Northern Hemisphere," in which the historical causes determining the present flora of the valley are treated of. The whole of this portion of Professor MacMillan's work, and in particular the section last referred to, seems to have furnished not only the inspiration, but the ideas, and no little of the language of the article in the *Naturalist.*

How far the terms which Professor MacMillan has found to express the phenomena he there discusses have become common property so that they may be used by all without credit, is a question I will not consider. But it would seem that his ideas, if not copyright, are not yet so far in the past that they may be safely drawn on by all comers and used as "raw material" for the "manufactured product" so commonly met with in popular-scientific articles.

By comparing the article entitled "The Meaning of Tree Life" in recent issues of the *Naturalist* with the portions of Professor MacMillan's work referred to above, and also with his note on "Cretaceous Plant-Physiognomy" in the *Naturalist* of April, 1893, it will be perceived that the latter two have furnished the trend and order of argument, a large portion of the ideas, and a considerable portion of the terminology of the former. More than that, a part of it has the air of an ingenious paraphase of Professor MacMillan's work. The style of the *Naturalist* article is, rhetorically, so far removed from ordinary scientific writing, and so much skill in the use of language has been brought to bear upon the paragraphs of the "Metaspermæ," that the influence of the latter is at first scarcely recognizable. But in several places the original is unmistakable. Under such circumstances it may well be asked whether the quotation of one of the most notable sentences of Professor MacMillan's book as the words of a "recent writer" is a sufficient acknowledgment.—ROSCOE POUND, *Lincoln, Neb.*

NOTES AND NEWS.

DR. A. ZIMMERMANN has been advanced to professor "ausserordentlich" in the University of Tübingen.

THE LAST PART of Husnot's Muscologia Gallica was announced for issue in September, and will probably appear shortly.

THE EUROPEAN and North American species of Polytrichaceæ are revised by N. C. Kindberg in *Revue Bryologique* **21**: 33. 1894.

IN *Garden and Forest* (Sept. 12) Mr. J. N. Rose gives an account of the tree Ipomœas of Mexico, describing a new species with illustrations, and also reproducing a capital photograph of a grove of tree Ipomœas.

THE ANNOUNCEMENT by Lord Rayleigh and Professor Ramsey of a new gaseous constituent of the atmosphere, made to the British Association at its last meeting, may prove of much importance to vegetable physiologists.

PROFESSOR GEO. F. ATKINSON has published in *Bull. Torr. Bot. Club* (August) a preliminary paper on Some Exoasceæ of the United States. Sixteen species or varieties of Exoascus are noted, ten of which are new, and one Taphrina.

MR. G. MASSEE is publishing in *Grevillea* revised descriptions of type specimens of fungi in the Kew herbarium, a very useful piece of work since many have been very briefly and imperfectly described. Among them we notice many North American species.

COPIES of the Proceedings of the Madison Botanical Congress have been distributed to a large number of botanists, and may be had by those interested on application to the Secretary, Dr. J. C. Arthur, Lafayette, Indiana. Send four cents in stamps for postage.

THE DIFFICULTIES in the cultivation of black pepper in the West Indies have been successfully overcome in Trinidad, as we learn from a bulletin (no. 23) of the Royal Botanic Gardens. A crop of some 200 lbs. has been harvested and samples have received highly satisfactory valuation.

IN *Erythea* for August Mr. J. Burt Davy begins the very useful publication of transcripts of descriptions of Californian genera and species from rare publications. This first paper contains genera and species described in the St. Petersburg Imperial Botanic Garden Seed Lists from 1834 to 1844.

SCIENCE seems to have been largely absent from the seventh annual meeting of the Association of American Agricultural Colleges and Experiment Stations, judging from the volume of *Proceedings* recently issued. The only reference to botany appears to be two short set of notes by Prof. B. D. Halsted, on Solandi printing and fungi, given in the appendix.

PARTS 106–108 of *Die natürlichen Pflanzenfamilien* have been distributed, containing the completion of Cactaceæ and the Bignoniaceæ by K. Schumann, the Geissolomaceæ, Penæaceæ, Oliniaceæ, Thymelæaceæ, and Elæagnaceæ by E. Gilg; and the Gesneriaceæ and Columelliaceæ by Karl Fritsch.

PROFESSOR JOHN M. COULTER has been appointed "Professorial lecturer" in Botany at the University of Chicago, in charge of the graduate work. This is the beginning of the development of a department of botany which is to be put upon the same footing as the other departments of the university.

THE SEPTEMBER number of the *Forstlich-naturwissenschaftliche Zeitschrift* contains the first installment of a paper entitled: "A contribution to the history of the development of buds in some deciduous trees," by Dr. Paul Albert, together with several other papers of less botanical interest.—L. S. C.

MR. J. M. BATES in some notes on shrubs of Nebraska (Am. Nat. 28, 803) records finding Salix tristis five feet in height, and Salix cordata about twenty feet high and eight inches in diameter. He also states that Œnothera serrulata is occasionally shrubby, two to six inches of ligneous stem surviving the severest winters.

THE LAST *Erythea* (September) announces the purpose of Professor Greene's mission in Europe. He will visit Kew and the great continental herbaria for a critical study of the types of Pacific Coast plants. It is a fortunate thing that Professor Greene can make this study, as no one is so well fitted to make it of lasting value.

GERMAN INVESTIGATORS find that yeast grown upon different substrata, as gypsum blocks and clay tiles, show decided differences in the formation of the spores. Satisfactory comparison with previous work can only be made, when cultures are carried out under the same conditions as the work with which comparison is to be made.

SUR LES Myxobactériacées, nouvel ordre de Schizomycètes, is the title of Dr. Roland Thaxter's paper, which was printed in this journal for December, 1892, as it appears in the *Revue Mycologique* for July, 1894 (pp. 92–108). It was translated by O. J. Richard and R. Ferry. Only about half the figures of the four plates are reproduced.

MR. A. CURTISS, of Jacksonville, Fla., has just sent out lists of 400 Florida plants of his own collection this year, which constitute the first two fascicles of a new distribution of plants of the southern states. Those who remember the beautiful series of seven fascicles distributed by Mr. Curtiss from 1877–1886 will want to have these also.

THE HERBARIUM of the U. S. Department of Agriculture is being removed from the quarters it has so long occuped in the Agricultural Building into the National Museum. This will consolidate what have heretofore been two herbaria, insure safety from fire, making reference more convenient, and give more room to the much crowded Division of Botany.

THE DIVISION of Vegetable Pathology of the U. S. Department of Agriculture is desirous of including physiology within the scope of

its labors, very justly maintaining that the best work in pathology is based upon an understanding and development of physiology. It is a departure that all friends of botanical science, in both its pure and applied forms, will be glad to see.

M. LEON GUIGNARD, who first demonstrated the existence of "directive spheres" in plants (Compt. rend. 9 March, 1891) has begun the publication of a series of papers "Sur l'origine des sphères directrices" in *Journal de Botanique* (July 16), called out by subsequent publications. Some botanists seem to have confounded with the directive spheres structures of an entirely different nature.

THE REPORT of the director of the office of experiment stations for 1893, just issued, shows that in the fifty-five stations in the United States there are employed thirty-seven botanists, of which seventeen also give attention to other lines of work. Half of the stations employ no botanist, while only three are without a chemist. Altogether there are three chemists employed to one botanist.

IN THE *Journal of Botany* the description of new tropical African plants continues, among them ten Acanthaceæ (one a new genus, Homilacanthus) by Spencer Le M. Moore, a new tree Senecio by E. G. Baker, and fifteen new Ericaceæ (twelve of which are Ericas) by Harry Bolus. In the May number four new British brambles are described, and in August seven new species of Hieracium!

THE INTERESTING fresh-water alga, which occurs abundantly in the lakes of Minnesota and adjoining states in the form of floating granules of the size of turnip seeds, at first called Rivularia fluitans and afterwards Gloiotrichia Pisum, has been studied by Paul Richter of Leipzig. He calls it *Gloiotrichia echinulata* (Engl. Bot.) P. Richt., and considers it to be a species distinct from the larger form, *Gloiotrichia fluitans* (Cohn).

AN ELABORATE PAPER on our present knowledge of the bacteria by Professor L. H. Pammel is printed in the proceedings of the Iowa Academy of Sciences for 1893. It is the presidential address at the last annual meeting; but what is not common in such cases, it is accompanied by references to the literature from which the statements of facts have been taken, there being no less than 148 citations. It is a mine of facts, and a most valuable résumé.

IN *Bulletin de l'Herbier Boissier* for July, M. Micheli describes six new Leguminosæ from Central America, each illustrated by a beautiful plate; Otto Kuntze gives a set of "Nomenclatur-Studien", in which he fully considers certain recent propositions of Pfitzer in Engler's Jahrbücher, and also those of the Madison Congress (notably priority of place and the law of homonyms); and A. Kasimir discusses the forms of the oxalate crystals of Opuntia and Pereskia. In the August number C. DeCandolle describes some new Meliaceæ from South America.

AS A résumé of a work published in Danish last year[2] M. Rosen-

[2]Groenland's Havalgar. Extr. des Meddelelser om Groenland **3**: 763–981. 1893.

vinge publishes, in Ann. d. Sci. Nat. Bot. VII. 19: 53 ff. My 1894, Les algues marines du Groenland. The work is based on the rich collections of the botanical museum at Gopenhagen, which were begun at the end of the eighteenth century by Fabricius, Giesecke, and Wormskiold, and were greatly augmented by Vahl during his eight years sojourn in Greenland, as well as by the abundant contributions of later collectors, including Th. Holm, N. Hartz, and the author. The paper is profusely illustrated by text cuts.

P. KOSSOWITCH has conducted a careful series of experiments in re-examination of the question whether the algæ can fix free nitrogen. He operated with pure cultures of various algæ, obtained in an ingenious way and cultivated in an apparatus of rather complex construction for which the original paper must be consulted.[1] In the entire series of experiments with algæ in pure cultures there was no increase of nitrogen, but when they were mixed with soil bacteria and fungi there was in part a considerable increase of N. Which of the organisms was responsible for this has not yet been determined.

DR. E. L. STURTEVANT has published in *Bull. Torr. Bot. Club* (August) a series of notes on maize, which brings together a very large amount of interesting information. An improved nomenclature for maize is proposed. Taking Z. tunicata as a primitive form, five species are derived, Z. everta (pop corns), Z. indurata (flint corns), Z. indentata (dent corns), Z. amylacea (soft corns), Z. saccharata (sweet corns), and Z. amyleasaccharata (starchy-sweet corns). Each of these five furnished three well-defined sub-species, A, B, and C, dependent on the relation between the diameters of the kernel. All the literature concerning corn and its cultivation has evidently been consulted, but the author considers our data as yet too imperfect to hazard an opinion as to the original locality of maize cultivation.

THE UNIVERSITY OF MINNESOTA has purchased Dr. J. H. Sandberg's collections and will conduct his uncompleted exchanges according to the accounts as indicated in his ledgers. From this collection some 22,000 plants are directly transferred to the University herbarium. The University will continue the exchange bureau feature and while the transfer may cause some delay in printing the annual list of plants offered, this list will be forthcoming as soon as possible and in the form of preceding lists. The University of Minnesota has also acquired a collection of 6,500 plants from Mr. G. B. Aiton, a well known and expert collector of western American plants, and some foreign sets of importance. The herbarium is estimated to contain about 140,000 specimens at the present time and is growing rapidly.

RECENT STATION BULLETINS having botanical character are as follows: The Russian thistle is treated by W. M. Hays (Minn. no. 33) from the economic side. Three half-tone illustrations and dissections of the flower give a good idea of the plant. Nevada weeds are discussed by F. H. Hillman (Nev. no. 22). The present bulletin treats of Hordeum jubatum, Franseria Hookeriana, Iva axillaris, Capsella

[1] Untersuchungen über die Frage, ob die Algen freien Stickstoff fixiren. Bot. Zeitung **52**: 97–116. 16 My 1894.

Bursa-pastoris, and Lepidium intermedium. A sprig and some seeds of each kind of weed are glued to the pages, and with some plates serve as excellent illustrations. An elaborate study of cotton fiber and of its improvement by crossing is given by P. H. Mell (Ala. no. 56). An interesting account of cultivated poplars (Cornell, no. 68) and of native dwarf cherries (Cornell, no. 70) is given by L. H. Bailey, both being unusually well illustrated. Twelve species of poplar and a number of varieties and three species of cherries are described. The latter include a new species, Prunus Besseyi, and a hybrid of P. Besseyi and P. Watsoni. Crown knot, a disease of fruit trees of unknown origin is treated by J. W. Toumey (Ariz. 2, no. 1.

RESEARCHES ON the structure of the Terebinthaceæ by M. Jadin,[1] embracing an examination of 207 species distributed through sixty-seven of the seventy-one genera, show that the stem is always characterized by the secretion canals developed in the phloem and protected by "pericyclic" fibers. This feature is so constant that it seems to be the most important character of the family. The characters furnished by the stem do not suffice to distinguish the genera, though in some cases they may be used to supplement the external morphology. The absence of medullary canals is constant in some genera; their presence is constant in others; and again in some they are either present or absent, for which fact no satisfactory explanation was discovered.

MR. E. BELZUNG calls attention to an important discovery in relation to the rôle of calcium oxalate, viz., its existence in the embryos of papilionaceous Leguminosæ in a state of solution or, more exactly, loose combination with the free acids of the cell sap, e. g., as citroxalate or oxoxalate of calcium. This is independent of the visible, partly crystalline, partly granular, calcium oxalate, and is prepared to play the rôle of a nutritive reserve. Since oxalate of calcium may exist in considerable quantity exclusively in a dissolved state, the determination of the absence of crystals of this salt is not sufficient ground for predicating its absence in any given species. Lupinus luteus, for example, has the oxalate crystals in its cotyledons, while in the same organs of L. albus it is all in the dissolved state. But both have crystals in the internal fibrous layer of the hard pericarp. Here however the precipitation of the oxalate is connected with the lignification of the cell walls and is brought about by the resorption of the cell contents, so that it must be looked upon as a product of cellular inanition and not a principle which again participates in normal life.

S. NAWASCHIN contributes to the *Berichte* der deutschen botanischen Gesellschaft,[2] a preliminary account of his researches on the embryology of the Betulaceae. He claims to have priority over Miss Margaret Benson's publication regarding the chlazogamic fertilization in these plants (see this journal 19: 299. Jy 1894).

In the present paper he summarizes his conclusions regarding the birches and alders. He finds that the fundament (*Anlage*) of the flower is formed of an axillary shoot whose apex is concealed in the

[1] Ann. d. Sci. Nat. Bot. VIII. **18:** 151. My 1–894.

[2] Kurzer Bericht meiner fortgesetzen Studien über die Embryologie der Betulineen. l. c., **12:** 163–169. 31 Ag 1894.

depression between the two carpellary leaves. The two stigmas and the style canal are developed from these carpels later, whereas much the greater part of the ovary is produced by later intercalary growth of the floral axis. The *anlage* of the ovules appear as lateral swellings of the floral axis which grows to form the wall of the ovary; and the alteration produced by the intercalary growth of the axis is such as to make these ovules appear to be upon the margin of the carpels, while in fact they are situated upon an axile placenta which is a columnar prolongation of the axis, and are homologues of leaves. The ovary even at maturity is not closed, the style canal being open; the pollen tube, however, does not pass through it, but penetrates the tissues of the swollen margins of the carpels, of the upper part of the placenta, of the funiculus, and finally of the chalaza, reaching by this route the apex of the embryo sac. Here it broadens irregularly and sends out a number of long outgrowths which not rarely surround the embryo sac from apex to base. The antipodal cells and egg apparatus are as usual, but the two remaining nuclei do not fuse until fertilization proper occurs.

Three stages are marked in this course of development: first, before pollination the ovary is undeveloped, the flower axis has formed the two first leaves (carpels) and its apex forms a yet simple axile placenta; second, at the time of pollination the two carpels have reached their full development, constituting two stigmas and a short style canal, and the axis is forming the next pair of leaves as the ovular anlage; third, at the time of fertilization the carpels are long since dried, the ovary has been fully formed and the ovules have just reached their full development.

Nawaschin concluded that there must be an intermediate type between the chlazogamous and porogamus angiosperms and has discovered it in the Ulmaceae. At the time of pollination the ovules are almost ripe; the pollen tube passes through the short style and descends the funiculus half the length of the ovule and then directs itself to the apex of the nucellus which it reaches by penetrating both integuments!

In discussing briefly the evolution of the ovule and fertilization, Nawaschin holds with Agardh that the so-called gymnospermous ovule is to be looked upon as an ovary, the nucellus being an axile placenta containing an ovule limited to the embryo sac (the so-called corpuscula).